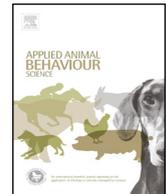




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The acquisition and maintenance of dogs' aversion responses to kiwi (*Apteryx* spp.) training stimuli across time and locations

Arnja R. Dale^{a,b,*}, Shivaun Statham^a, Christopher A. Podlesnik^b, Douglas Elliffe^b

^a Animal Welfare Group, Department of Natural Sciences, Unitec Institute of Technology, Private Bag 92925, Auckland, New Zealand

^b School of Psychology, The University of Auckland, Private Bag 92019, Auckland 1142, New Zealand

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ABSTRACT

Dogs (*Canis familiaris*) pose a significant threat to kiwi (*Apteryx* spp.) through predation. In an attempt to balance kiwi conservation and the need for dogs to be used for hunting purposes in kiwi habitat, the New Zealand Department of Conservation (DOC) developed the Kiwi Aversion Training (KAT) programme. KAT involves a training session in which a dog is presented with KAT stimuli (stuffed kiwi, frozen kiwi, and kiwi feathers) and a brief period (0.5–1.5 s) of aversive electrical stimulation from an electric shock collar is applied when the dog makes contact with the training stimuli. This paper reports three experiments: (1) investigating whether dogs can learn to avoid the KAT stimuli through aversion training; (2) investigating maintenance of aversion to the KAT stimuli 1 month after initial training; and (3) investigating maintenance of aversion to the KAT stimuli 1 year after initial training. All dogs showed aversion responses to the KAT stimuli during the initial KAT training and also when exposed to the KAT stimuli 1 month after training without an electric collar being worn. 1 year after initial training, 87% (48/55) of dogs avoided the KAT stimuli. This research indicates that KAT effectively produces aversion towards the KAT stimuli that generalizes to another location, is independent of the electric collar being worn, and that lasts at least 1 year after training.

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1. Introduction

Kiwi (*Apteryx* spp.) populations have been in decline since the arrival of humans to New Zealand more than 700 years ago, resulting in all species currently being at risk, and some precariously close to extinction (Holzapfel et al., 2008). The kiwi is *taonga* (treasure) to Māori (indigenous people of New Zealand), is equally treasured by all cultures

in New Zealand, and is a significant national icon (Holzapfel et al., 2008). The North Island brown kiwi is classified as “Nationally Vulnerable” (Miskelly et al., 2008) and kiwi abundance in most North Island forests has declined by at least 90% over the last century (McLennan et al., 1996). Habitat destruction is an important factor in this, but most of the decline is due to predation by introduced pests such as ferrets (*Mustela putorius*), possums (*Trichosurus vulpecula*), stoats (*Mustela erminea*), cats (*Felis catus*) and dogs (*Canis familiaris*) (e.g. McLennan et al., 1996; Pierce and Sporle, 1997). Dogs are the primary killer of adult kiwi (Holzapfel et al., 2008) and this predation can cause catastrophic declines in local populations (Pierce and Sporle, 1997; Taborsky, 1988) and can strongly influence

* Corresponding author at: Animal Welfare Group, Department of Natural Sciences, Unitec Institute of Technology, Private Bag 92025, Auckland, New Zealand. Tel.: +64 9 815 4321x7321; fax: +64 9 815 4346.

E-mail address: adale2@unitec.ac.nz (A.R. Dale).

population trends by significantly reducing the life expectancy of adults in some areas (e.g. Northland) (Holzapfel et al., 2008).

Given the threat that dogs pose to kiwi, banning dogs from areas where kiwi live would appear to be the simplest solution but this is impractical for many reasons. Some kiwi habitats are either privately owned or adjacent to private land, or are publicly owned land where dogs are allowed. Dogs also provide benefits in reducing introduced predators and grazing species that damage kiwi habitat, with dogs being commonly used and necessary for hunting feral pigs (*Sus scrofa*), deer (*Cervus* spp.) and goats (*Capra hircus*), often in remote areas. This is considered an essential method of pest control by the Department of Conservation (DOC). In addition to this, prohibition of dogs from kiwi habitat may impact negatively on kiwi conservation if DOC's dog-control approach is perceived by dog owners as too rigid or inconsistent, even though kiwi conservation is an issue that is well supported by the New Zealand public (James, 2000).

Given that there are approximately 700,000 dogs in New Zealand (Mackay, 2011), a solution was therefore sought that would allow dogs to be used for recreational and professional hunting in conservation areas containing kiwi populations while minimizing the risk to kiwi. Accordingly, the Kiwi Aversion Dog Training Programme (KAT) was developed, funded by the Bank of New Zealand Recovery Trust in association with DOC. The KAT procedure involves a training session in which a dog is presented with one or more kiwi stimuli (frozen dead kiwi and stuffed kiwi) and a brief period (0.5–1.5 s) of electrical stimulation from an electric shock collar is applied when the dog makes contact with the KAT training stimuli. The dog passes the training if the dog displays aversive behaviours to the KAT stimuli after being shocked, i.e. not looking at or going near the training stimuli. Information regarding the dangers of dogs to kiwi is also provided to owners along with a KAT certificate. The purpose of KAT is to train dogs to associate the sight and/or odour of kiwi training stimuli with the shock so that they will avoid kiwi if encountered in the future.

While there is anecdotal evidence from dog owners and DOC staff that suggests the KAT training results in kiwi aversion when dogs encounter live kiwi, only one study has examined the efficacy of the programme (Jones, 2006). That study had a very small sample size of 13 dogs and concluded that the KAT training is not effective. However, a number of studies have demonstrated that response-contingent electric shock can in certain conditions reduce or eliminate predatory behaviour in Canidae species (e.g. Andelt et al., 1999; Christiansen et al., 2001; Hawley et al., 2009; Linhart et al., 1976). Most of the studies investigating aversion learning in canids have been conducted while searching for non-lethal methods of controlling predation of domesticated animals by non-domestic canids such as coyotes (*Canis latrans*), foxes (*Vulpus vulpus*), wolves (*Canis lupus*), and feral dogs (*Canis familiaris*), as opposed to endangered ground-dwelling birds as is the case with the KAT programme in New Zealand.

The KAT programme started in 1997 in the DOC Hau-raki Area Office and has issued more than 1500 permits for dogs in the Coromandel region in the North Island

of New Zealand. KAT is not mandatory for all dogs but is encouraged for dogs that live in kiwi habitat and is required if hunting on DOC land as part of the requirement for a hunting permit in kiwi habitat (e.g. Waikato and East Coast/Hawke's Bay conservancies). Some forestry companies and private landowners have also made KAT a requirement for hunting in kiwi territory. There is a large community uptake and support of the importance of this training programme throughout the Coromandel region. However, the usefulness of the programme is relatively controversial due to the time, effort, and money invested in the KAT by the DOC without knowing if it is actually working in stopping or reducing the number of dogs killing kiwi. This research examines whether dogs avoid KAT stimuli during the initial KAT training, the retention of that learning in tests 1 month, and 1 year after initial training, and whether the learning generalizes to locations other than that used in training.

2. Methods

2.1. Animals

Pig and/or goat hunting dogs ($n=120$) were sourced from consenting owners during DOC run KAT sessions. There were three groups of dogs: the 'Naïve' group consisted of naïve dogs undergoing their first KAT session (65 dogs); the '1 Month Retest' group consisted of dogs returning 1 month after their first KAT session (15 dogs sourced from 'Naïve' group); and the '1 Year Retest' group consisted of dogs returning 1 year after their first KAT session (55 dogs). None of the 1 Year Retest group were in the Naïve group or the 1 Month Retest group. Demographic data was not recorded.

2.2. Procedures

The KAT training took place at sites consisting of a walking path in native forest with KAT stimuli set up in the middle of the track. The KAT stimuli consisted of two stuffed kiwi, and one partly thawed frozen kiwi carcass. Dogs were fitted with an Agtronics Smart Aid 4 electric training collar (manufactured by Pet Training Products, New Plymouth, New Zealand) which delivered 0.0092 joules of electric shock when operated. Each dog was individually walked past the KAT stimuli with its owner/handler, either on a long lead or under voice control with the decision dependent on whether the site potentially had endangered species present and also the owner's control over the dog (Long line use: Naïve dogs, $n=39/65$; 1 month Retest $n=0/15$; 1 Year Retest $n=12/55$). Dogs were given the opportunity to observe and approach the KAT stimuli, and when contact was made (defined as sniffing the training stimuli), an electric shock was administered via a remote control handset controlled by the DOC trainer/assessor. For dogs undergoing KAT for the first time (Naïve group), if the dog did not voluntarily sniff the KAT stimuli, the dog would be encouraged to do so by the DOC trainer/assessor and once contact was made would be shocked. The majority of the dogs were walked past the KAT stimuli for a second time to assess the behaviours

the dogs made towards the KAT stimuli. If contact was made with the KAT stimuli, a second shock was administered. Some dogs were not walked past the KAT stimuli for a second time because they refused to return to the KAT training area; this was regarded as a sufficient demonstration of avoidance. Dogs from the '1 Month Retest Group' and the '1 Year Retest Group' were not encouraged to sniff the training stimuli. Electric collars were not worn for the '1 Month Retest Group', but were for the '1 Year Retest Group'. Seven of the '1 Month Retest' group dogs (15 dogs sourced from 'Naïve' group), were presented with the KAT stimuli 1 month after the initial KAT training at the initial KAT training location and eight at a novel location but still in a forest setting. These 15 '1 Month Retest' dogs were presented with the same KAT stimuli in the same manner used in the initial KAT training, but these 15 dogs did not wear the electric collar, and no shock was administered. Twenty-nine of the annual KAT retest dogs ('1 Year Retest' group) were retested at the same location where they were initially KAT trained and 26 were retested at a novel site. In some cases, avoidance was so strong that we were unable to get the dogs within 50 m of the kiwi stimuli.

2.3. Canine response rating

Responses of the dogs to the KAT stimuli were rated on the following scale: (1) Strong aversion of KAT stimuli: did not approach vicinity of KAT stimuli, had to be forcibly led to walk past KAT stimuli, run away; (2) Moderate aversion of KAT stimuli: reluctant to approach vicinity of KAT stimuli, gave KAT stimuli a wide berth when walked past, did not sniff KAT stimuli, no physical contact with KAT stimuli; (3) Indifferent to KAT stimuli: Showed no interest or aversion of KAT stimuli when walked past KAT stimuli, did not sniff KAT stimuli, no physical contact with KAT stimuli, was not reluctant to stay in vicinity of KAT stimuli; (4) Showed moderate interest in KAT stimuli: air sniffed in direction of KAT stimuli, slowly approached KAT stimuli, sniffed close to the KAT stimuli, no physical contact made with KAT stimuli; and (5) Showed strong interest in KAT stimuli: quickly approached KAT stimuli, sniffed KAT stimuli, made physical contact with KAT stimuli.

Each dog was assigned its own identification number and received a rating number from the above scale. For the 65 naïve dogs ('Naïve' group), a response to KAT stimuli was recorded before and after the KAT. Dogs from the '1 Month Retest' and '1 Year Retest' group received a response to the KAT stimuli only. Data on the behavioural response of the dogs to the electric shock collar were collected, but are not reported in this paper.

Table 1

Responses of dogs to the Kiwi Aversion Training (KAT) stimuli.

KAT session	Response to KAT training stimuli				
	Strong aversion (<i>n</i> = 87)	Moderate aversion (<i>n</i> = 42)	Indifference (<i>n</i> = 5)	Moderate interest (<i>n</i> = 47)	Strong interest (<i>n</i> = 19)
Pre initial KAT (<i>n</i> = 65)	0	1	5	40	19
Post initial KAT (<i>n</i> = 65)	52	13	0	0	0
One month post initial KAT (<i>n</i> = 15)	7	8	0	0	0
One year post initial KAT (<i>n</i> = 55)	28	20	0	7	0

2.4. Statistical analysis

Statistical comparisons using the following tests were made between the three groups of dogs to the KAT stimuli using non-parametric tests reflecting the lack of normal distribution within the data. The Wilcoxon matched-pairs signed-rank test was employed to compare responses of dogs before and immediately after KAT training, and immediately after training and 1 month later. The difference between location of KAT training and the location of the KAT stimuli re-exposure 1 month or 1 year later was tested using the Mann–Whitney *U* test, as was the comparison between responses to the KAT stimuli during the initial KAT training and during the 1 year KAT retest. Cohen's *r* was used to test the effect size and power analysis was conducted using GPower (Version 3).

3. Results

Table 1 illustrates the responses of dogs to the KAT stimuli for all three groups. Naïve dogs ('Naïve' group, *n* = 65) showed significantly higher levels of interest in the KAT stimuli immediately before KAT training (median = 4) than immediately after (median = 1), $T = 0$, $z = -7.2$; $P < 0.001$; $r = -0.93$; $1 - \beta = 1.0$. The responses of dogs ('1 Month Retest' group, *n* = 15) to the KAT stimuli before KAT training (median = 5) and 1 month after KAT training (median = 2) were also significantly different, $T = 0$, $z = -3.571$; $P < 0.001$; $r = -0.92$; $1 - \beta = 1.0$, but the responses immediately after (median = 1) and 1 month after KAT training (median = 2) were not significantly different, $T = 8$, $z = -1.134$; $P = 0.257$; $r = -0.29$; $1 - \beta = 0.702$. This result occurred despite the '1 Month Retest' dogs not wearing an electric collar. There was also no significant difference in response to the KAT stimuli 1 month after KAT when comparing the original training site (median = 2) and the novel site (median = 2), $U = 26.00$, $z = -0.267$; $P = 0.789$; $r = 0.069$; $1 - \beta = 0.081$. All dogs showed either moderate (rating = 2) or strong aversion (rating = 1) immediately after KAT, 1 month after KAT and 1 year after KAT training. There was no significant difference in the responses of Naïve dogs ('Naïve' group, median = 1) after KAT training and the responses of dogs to the KAT stimuli in the '1 Year Retest' group (median = 1), $U = 1700.00$; $z = -0.511$; $P = 0.609$; $r = 0.047$; $1 - \beta = 0.181$. There was also no significant difference in response to the KAT stimuli 1 year after KAT when comparing the original training site (median = 1, *n* = 29) and the novel site (median = 1.5, *n* = 26), $U = 326.00$, $z = -0.280$; $P = 0.780$; $r = 0.038$; $1 - \beta = 0.085$. Of the 55 dogs returning 1 year after their initial training, only 12.7%

(seven dogs) showed interest in the kiwi stimuli and had to receive a shock, after which all seven dogs showed strong aversion (score 1) to the KAT stimuli.

4. Discussion

The results suggest that KAT training produced aversion responses to the training stimuli in the absence of the shock collar, and that aversion was not solely linked to the original training site. In addition, these aversion responses consistently lasted for at least 1 month after training and for 1 year in a large majority of dogs. Only a small percentage of dogs (13%) were required to be re-shocked for displaying behaviours that indicated interest in the KAT stimuli 1 year after their initial KAT training, all of these dogs were restrained on a long line. Long lines were utilized if endangered species were present in the area and/or if the dog was not under voice control of the owner. These restraints are not used whilst hunting so could have affected the behaviour of the dogs during the training and testing sessions. If the reason for their use for the dogs that required shocking at the 1 year test was lack of control of the dog, this does have implications for the 'bird-safe' aspect of these dogs. Also if the 1 year retest dogs had not been wearing the electric collar it is possible that this figure may have been higher. In addition to this, it is also possible that the aversive response from the KAT had been extinguished by encountering prey without any associated punishment. Data on hunting activity during the year would have been beneficial to have been collected.

This research is consistent with a number of published reports that demonstrate pairing and electric shock with potential prey can establish prey aversion in canid species (e.g. Andelt et al., 1999; Christiansen et al., 2001; Cooper et al., 2005; Hawley et al., 2009; Linhart et al., 1976; Schultz et al., 2005). These studies all used live prey, rather than training stimuli of live prey as in the present study for training purposes. The sample sizes were also considerably smaller than with this research. This study also used a single training session, rather than multiple training sessions as seen in other research (e.g. Christiansen et al., 2001; Linhart et al., 1976). Future research should expand on the present study by testing the effectiveness of KAT training with live kiwi. We acknowledge that there are many practical and ethical issues in using live kiwi in KAT. As an alternative, the question of generalization of avoidance to live birds could be explored at least initially with species of less conservation value (e.g., chickens).

Thirteen percent of dogs displayed moderate interest in the KAT stimuli 1 year after KAT training. While 100% of dogs displaying aversion behaviours would be ideal, it is unlikely that any training technique can achieve this level of effectiveness. There are a myriad of confounding factors (e.g. implementation differences among trainers, different electric collars used, and different training stimuli used) that affect learning in individuals. The level of kiwi avoidance at which the KAT programme is viewed as effective by the DOC is one that is debatable and likely to involve a cost-benefit analysis.

Some dogs displayed such strong aversion behaviours to the KAT stimuli that it was difficult to get the dogs within

50 m proximity to the KAT stimuli. Such strong aversion might indicate a potential welfare concern for the impact of KAT training on the health of the dogs. The use of electric training collars in dog training is controversial due to injury, stress, unwanted associations, and poor timing of shock administrations (Hiby et al., 2004; Houpt et al., 2007; Schalke et al., 2007; Schilder and van der Borg, 2003). The welfare impact of electric training collars in dogs can be reduced with dogs being able to predict shocks and control their response to it (Schalke et al., 2007). A warning sound prior to the shock being applied could be utilized within the KAT programme. Despite the welfare and/or ethical issues surrounding electric collars, there is research to support punishment being more effective in reducing instinctive behaviours in dogs, such as predatory instincts, when compared to reward based training (Marschark and Baenninger, 2002). Alternative non-lethal control methods such as the use of conditioned taste aversion to reduce predation by canids is very controversial, with mixed results, welfare concern and non-replicability being an issue (Gese, 2003). Further research comparing the effectiveness in alternate training methods in reducing canine predation on kiwi is recommended. The goal of protecting kiwi from being killed by dogs needs to be contrasted with the impact of KAT training on dog health and safety. Nonetheless, despite potential welfare concern, KAT training might provide a more humane canine management option than lethal control methods (e.g., poisoning, trapping, and shooting) that are legal in New Zealand for any dog in the vicinity of endangered species.

Other variables that might influence the effectiveness of KAT and that require further examination are the dogs' breed type, sex and age. In addition, the purpose for which the dog is kept, such as for companionship or hunting, should be examined. This is of interest as KAT trainers might not implement the same rigour in the training regime for pet dogs compared to working dogs, such as hunting dogs or DOC dogs. Conversely, some hunting dogs were extremely wary of the KAT stimuli in this research even before KAT training, perhaps because many owners had actively discourage their dogs from interacting with any animals other than those that they are trained to hunt. The effects of previous experience of the dogs within this training programme would also be worth investigating.

It is possible that if hunting dogs were to become lost or injured, food deprivation might override the aversion training. Also, it is also not known how KAT-trained hunting dogs would respond to kiwi in the absence of the hunter, which often can be for long periods of time (up to 5 h). Finally, it is unknown how dogs might respond to the KAT stimuli after multiple KAT training sessions, nor how far beyond 1 year these aversion responses are maintained. These questions are important to understand and require further investigation as some DOC conservancies are moving from an annual KAT permitting system to a 3 year permitting system.

In conclusion, this research has demonstrated that KAT is effective in that the majority of dogs avoided the KAT stimuli, regardless of whether an electric collar was worn, and that the training generalized to other locations and lasted for at least 1 year. KAT also offers public-relations

value for the DOC and for kiwi conservation in general. With the educational value that KAT provides in the dangers of dogs to kiwi, it is hoped that owners will display higher levels of responsible dog ownership in known kiwi-populated areas, and attend KAT training and retest sessions. Given how vulnerable and important kiwi are to New Zealand, further research into KAT is warranted, especially examining how the current KAT training with kiwi stimuli translates to live kiwi for dogs.

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